

Whitefly management in greenhouse vegetable crops

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Whitefly

Greenhouse whitefly *Trialeurodes vaporariorum* (GWF) and Silverleaf whitefly *Bemisia tabaci* Biotype B (also known as *Bemisia argentifolii*) (SLWF) are common potentially major pests in greenhouse crops. Whitefly can become a problem in the summer months or under dry warm conditions. Whiteflies are inclined to be found in the hot spots of greenhouses as the temperatures suit their breeding cycle.

Q biotype Whitefly a new strain of the *Bemisia tabaci* species complex has been discovered in vegetable crops in north Queensland in late 2008, and southern Queensland and north-western NSW in 2009. It is an important detection because it has the capability to develop rapid resistance to some insecticide groups, particularly if those insecticide groups are frequently used. Outside of Australia, Q biotype has developed high resistance to neonicotinoids such as Confidor® and insect growth regulators (IGRs) such as Admiral®. This has resulted in serious control issues, especially in greenhouse cropping situations. These biotypes are visually indistinguishable and can only be identified using molecular or biochemical techniques.

Whiteflies suck the sap from plants, they may wilt, turn yellow, shed leaves and display reduced growth rates if infestations are severe. The pest produces honeydew, encouraging sooty mould growth, which reduces photosynthesis and decreases plant vigour. Feeding by whiteflies can also cause deformed fruit and discoloration of tomatoes, through uneven ripening. These pests

are vectors of some plant viruses (discussed later in this Primefact).

The GWF and SLWF are major pests in tomatoes (*Lycopersicon esculentum*) and cucumbers (*Cucumis sativus*) and minor pests in other



Figure 1. Whitefly infestation on tomatoes



Figure 2. Sooty Mould on cucumber (Image courtesy of Paul De Barro, CSIRO)

Cucurbits and Solanaceae crops such as eggfruit. Their weed hosts for GWF include verberna, mallow and sowthistle and milk thistle for SLWF.

Whitefly description

Greenhouse whitefly *Trialeurodes vaporariorum*

Once the egg is laid it is usually 7 days until the nymph emerges. Around 14-35 days later the nymph develops into a pupa. This pupa has a few long hairs and usually is recognised as whitefly scale by the layman. Then 9-23 days later the pupae burst open and fully grown winged adult GWF emerge, ready and able to lay eggs. Generally the GWF lifecycle is 30-65 days in length, depending on environmental conditions.

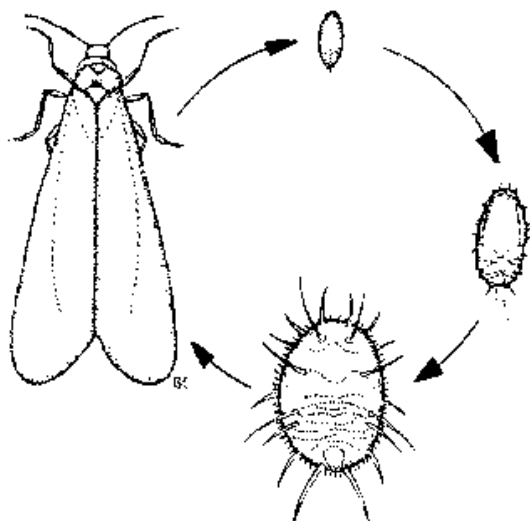


Figure 3. Greenhouse whitefly lifecycle – Varies from 30-65 days (Drawing courtesy of Briony Cowper)

Silverleaf whitefly *Bemisia tabaci* Biotype B and Q biotype

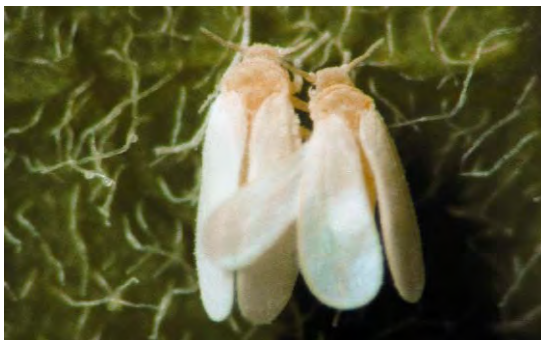


Figure 4. Adult silverleaf whitefly (Image from Pests, diseases, disorders and beneficials in Ornamentals: Field Identification Guide 3rd edition)

Once the egg is laid it is usually 7-10 days until the nymph emerges. Around 13 days later the nymph develops into a pupa. This pupa has a few short hairs and usually is recognised as whitefly scale by the layman. Then 6 days later the pupae burst open and fully grown adult SLWF emerge, ready and able to lay eggs. Generally the SLWF lifecycle is 26-30 days.

Morphology of whitefly pest

Adults

Adult whitefly can be found mainly on the underside of young leaves, as can the eggs and juveniles. To the naked eye GWF and SLWF look the same, but at closer inspection there are a few differences (definitive recognition is easier under a microscope). GWF adults appear moth-like with white wings held flat and roof-like over the body. The SLWF has a smaller body in comparison to the GWF, is generally yellower and holds its wings at a steeper angle or tent-like.

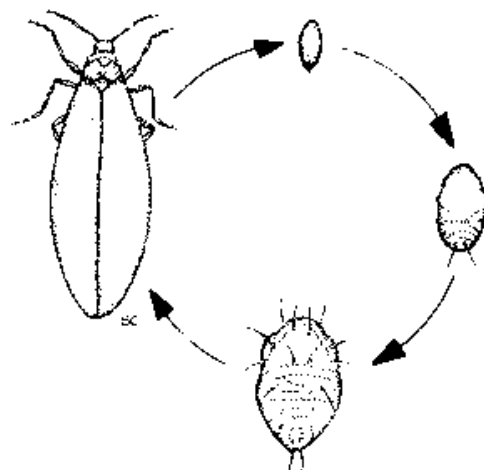


Figure 5. Silverleaf whitefly lifecycle – Varies from 26 to 29 days (Drawing courtesy of Briony Cowper)



Figure 6. Adult greenhouse whitefly (Image from Pests, diseases, disorders and beneficials in Ornamentals: Field Identification Guide 3rd edition)

Nymphs

Whitefly nymphs look scale like and can be mistaken as the egg stage of the lifecycle. GWF nymphs are white to a greenish-yellow, flattened and oval shaped. The pupa has a few long hairs and a fringe of very short hairs around the upper edge. SLWF nymphs are greenish-white in colour and oval shaped. The pupa tends to appear yellow, tapers towards the rear and lacks the spines around the rim that GWF display. Other hairs are variable, but there are usually only two at the rear. There is a parasitic wasp *Encarsia formosa* that is a biocontrol option for this life-stage of the whitefly (see whitefly management; biological control for further details).

Eggs

GWF eggs are small, yellowish when laid; darken to a greyish-purple when they're mature. They are laid on the underside of leaves, often in circles. SLWF eggs are the same in size to that of the GWF, yellowish-green when laid, turning light brown when



Figure 7. Greenhouse whitefly adult. Unparasitised nymphs are white, parasitised nymphs are black, *Encarsia parasitoid* (Image from *Pests, diseases, disorders and beneficials in Ornamentals: Field Identification Guide 3rd edition*)



Figure 8. Silverleaf whitefly nymphs (Image from *Pests, diseases, disorders and beneficials in Ornamentals: Field Identification Guide 3rd edition*)

mature. They are laid on the underside of leaves and scattered unlike GWF. The whitefly eggs usually go unnoticed as they are very small (maybe less than 1 mm) in length.

Vectors of viruses

Table 1. Known Australian vegetable hosts of whitefly and viruses

Virus	Vector	Host Plant
Tomato yellow leaf curl virus TYLCV	<i>Bemisia tabaci</i> Biotype B SLWF	Tomato (<i>Lycopersicon esculentum</i>) Capsicum (<i>Capsicum annum</i>) Chillies (<i>Capsicum chinense</i>) French beans (<i>Phaseolus vulgaris</i>)
Beet pseudo yellows virus BPV	<i>Trialeurodes vaporariorum</i> GWF	Lettuce (<i>Lactuca sativa</i>) Endive (<i>Cichorium endivia</i>) Cucumbers (<i>Cucumis sativus</i>)
Tomato torrado virus ToTV (Only found in SA)	<i>Trialeurodes vaporariorum</i> GWF <i>Bemisia tabaci</i> Biotype B SLWF	Tomato (<i>Lycopersicon</i> spp) Capsicum (<i>Capsicum annum</i>) Eggplant (<i>Solanum melongena</i>)

Whitefly management

Monitoring

The crop should be visually inspected for signs of whitefly infestation, looking out for suspicious plants that look stunted or chlorotic. Thoroughly inspecting individual plants at random for the presence of whitefly at any life stage using an x10 hand lens. Inspecting both surfaces of leaves is highly recommended to obtain a complete analysis of pest levels. Flagging locations where whiteflies are found assist in evaluating population development and control effectiveness. This should be routinely carried out on every scouting trip, preferably weekly, but the frequency of scouting should increase when whitefly levels are high or when conditions for whitefly breeding are heightened.

Trapping whiteflies using yellow sticky cards, both inside and outside the greenhouse, is a fundamental tool for a successful whitefly management program. The sticky cards are used to detect and monitor population levels and should be placed strategically throughout the greenhouse at 1 trap per every 100m². The traps should be hung just above the canopy of the crop as whiteflies are attracted to the young growth of the plants. Other

locations to consider hanging traps would be near doors, vents and previously known hot spots.

Biological control

There are natural enemies of whiteflies. Some are naturally occurring parasitoid wasps and pathogenic fungi. These are probably more accessible to a field crop than in a greenhouse situation. Although there is a commercially available parasitoid wasp called *Encarsia formosa* (supplied Biological services) as well as a predatory mite *Typhlodromips montdorensis* Monty (supplied by Beneficial Bug Company) and *Mallada signata* Green lacewing (supplied by Bugs for Bugs).

Encarsia formosa is commonly known as Encarsia. It is a parasitic wasp with orange coloured abdomen and black head and thorax. This tiny parasitic wasp lays its eggs into the second, third and fourth nymphal stages of whitefly. The Encarsia egg hatches inside the immature whitefly (also known as scale) and the wasp larva feeds inside of it. Within two weeks the scale turns black and a wasp emerges soon after.

Residual pesticides should cease for 4 weeks prior to introducing Encarsia.



Figure 9. *Encarsia formosa* parasitic wasp parasitising whitefly nymph

Using yellow sticky traps at 1 trap for every 100 m², monitor for the presence of whitefly, start releasing when they are present. Parasites should be introduced before the whitefly population is too high, alternatively, release Encarsia at the start of each crop, with the assumption that whitefly are present. For the best results apply weekly for 6 successive weeks of 2,000 parasites per 1,000 m² (noting that Encarsia are dispensed in lots of 100).

Mallada signata is commonly known as Green lacewing and are commonly seen in the field. Adults are 15 mm long with long lace like wings, eggs are laid on slim stalks, larvae have pinchers for attacking prey, are brown and carry debris on their backs. The larval stage is a predator of a range of pests including aphids, scale, two-spotted mite, moth eggs, small larvae and whiteflies.

Lacewings are supplied as eggs, larvae hatch shortly after arrival. Place the lacewing eggs

through infected plants. The suggested rate for protected cropping is: in highly infested areas the release rate should initially be higher at 1,000 eggs per 200 m², which should be followed by regular releases of 1,000 eggs per 1,000 m².

Broad spectrum spray applications should be avoided to protect the lacewings and avoid using residual chemicals.



Figure 10. Adult green lacewing (Image courtesy of Bugs for Bugs)

Typhlodromips montdorensis are commonly known as Monty's and is an Australian species of phytoseiid predatory mite collected in southern Queensland. They are small, pale pear shaped mites, equal in size to that of two-spotted mite; their eggs are slightly oval and translucent. Monty's are ferocious feeders of thrips and some mites, but in recently have been discovered feeding on egg stages and young larval stages of GWF. Due to this recent finding the use of montdorensis in commercial crops for the control of whitefly is in its infancy and research is in progress.

Eretmocerus hayati, a parasitoid of SLWF, was introduced into Australia from Pakistan and released



Figure 11. *Typhlodromips montdorensis* feasting on a greenhouse whitefly nymph

in crop production areas of Queensland in early 2006. It has spread to Narrabri and the Sydney Basin. Thus becoming a naturally occurring biocontrol, but isn't commercially available.



Figure 12. Female *E. hayati* (Image courtesy of Paul De Barro, CSIRO)



Figure 13. Male *E. hayati* (Image courtesy of Paul De Barro, CSIRO)

Cultural control

- Remove old and abandoned crops that shelter whitefly infestations and destroy plant debris and plant material that could potentially be infected with virus.
- Completely clean the production area at the end of the crop, if at all practicable. Remove all plant material, including weeds, for at least a week or more.
- Inspect new plant material before introducing it to the production area, plant resistant varieties where possible.
- In the greenhouse install physical barriers such as screens (whitefly grade mesh) with pore size of 400 microns (μm) or less to prevent adult whiteflies moving from infested areas or to prevent them from entering the greenhouse at all.
- It is wise to adopt good farm hygiene practices in regards to avoiding greenhouse cross contamination. If there are several greenhouses on any given property and there is an outbreak of

whiteflies or any other pest or disease in that matter, the cleanest greenhouse should be worked on first in the day working all the way through to the dirtiest at the end of the day. As this will reduce incidents of cross contamination between greenhouses.

- Eradicate weeds regularly from the production area and around greenhouse doorways, as they can support large populations of whiteflies. Laying weed matting or plastic as flooring will lessen weeds from being an issue within the greenhouse.
- Monitor whitefly populations by using sticky traps and weekly inspections to detect early infestations.

Chemical control

Use insecticides selectively, and alternate classes of insecticides to prolong use and to avoid chemical resistance developing. Thorough coverage on leaf surfaces, particularly the undersides of leaves for effective control. Target susceptible stages, usually adults and early nymphs. Soaps and oil sprays can give an effective control and for persistent infestations consider using systemic sprays.

Diagnosis

Using a diagnostic service to distinguish between GWF and SLWF can be of benefit as identification of SLWF can be difficult for the inexperienced.

References

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